

IMAQ™

NI-IMAQ™ for IEEE 1394 Cameras User Manual

Image Acquisition Software

Worldwide Technical Support and Product Information

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The following conventions are used in this manual:

» The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.



This icon denotes a note, which alerts you to important information.

bold Bold text denotes items that you must select or click in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

italic Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames, and extensions.

`monospace italic` Italic text in this font denotes text that is a placeholder for a word or value that you must supply.

Contents

Chapter 1

Introduction to NI-IMAQ for IEEE 1394 Cameras

About the NI-IMAQ Software	1-1
Application Development Environments	1-2
Configuring a IEEE 1394 Camera.....	1-2
Fundamentals of Building Applications with NI-IMAQ for IEEE 1394 Cameras.....	1-2
Architecture	1-2
NI-IMAQ for IEEE 1394 Cameras Libraries	1-3
Example Programs.....	1-4

Chapter 2

Basic Acquisition with NI-IMAQ for IEEE 1394 Cameras

Introduction.....	2-1
Acquisition Flow.....	2-2
Initialization.....	2-2
Camera Name.....	2-2
Camera Control Mode.....	2-4
Configuration.....	2-4
One-Shot/Continuous Acquisition	2-4
Number of Buffers	2-5
Region of Interest.....	2-5
Acquisition	2-6
User Buffer.....	2-6
Buffer Number	2-6
Overwrite Mode	2-7
Timeouts.....	2-7
Decoding	2-7
Programming Examples.....	2-8
High-Level Function Examples.....	2-8
Snap.....	2-9
Grab.....	2-10
Sequence	2-11
Low-Level Function Examples	2-11
Snap.....	2-12
Grab.....	2-13
Sequence	2-14

Chapter 3

Advanced Programming with NI-IMAQ for IEEE 1394 Cameras

Camera Attributes.....	3-1
Broadcasting.....	3-1
Implementation.....	3-2
Scalable Image Size.....	3-3
Trigger Modes.....	3-4
Trigger Mode 0.....	3-5
Trigger Mode 1.....	3-5
Trigger Mode 2.....	3-6
Trigger Mode 3.....	3-6
Trigger Mode 4.....	3-7
Trigger Mode 5.....	3-7

Chapter 4

Using NI-IMAQ for IEEE 1394 Cameras in LabVIEW

Introduction.....	4-1
Location of the NI-IMAQ for IEEE 1394 Cameras VIs.....	4-2
Common VI Parameters.....	4-2
IMAQ1394 Session.....	4-2
Image Buffer.....	4-3
Region of Interest.....	4-3
Acquisition VIs.....	4-3
High-Level.....	4-3
Low-Level.....	4-3
Buffer Management.....	4-4
Acquisition Types.....	4-5
Snap.....	4-5
Grab.....	4-5
Sequence.....	4-6
Triggering.....	4-7
Image Display.....	4-7
Camera Attributes.....	4-9
Error Handling.....	4-9

Chapter 5

Using NI-IMAQ for IEEE 1394 Cameras in C and .NET

Using NI-IMAQ for IEEE 1394 Cameras for C.....	5-1
Using NI-IMAQ for IEEE 1394 Cameras for Microsoft Visual Studio .NET 2003.....	5-2
Creating a New .NET Application.....	5-2

Appendix A
Register-Level Programming

Appendix B
Technical Support and Professional Services

Glossary

Index

Introduction to NI-IMAQ for IEEE 1394 Cameras

This chapter describes the NI-IMAQ for IEEE 1394 Cameras software, lists the supported application development environments (ADEs), describes the fundamentals of creating applications using NI-IMAQ for IEEE 1394 Cameras, describes the files used to build these applications, and explains where to find sample programs.

About the NI-IMAQ Software

NI-IMAQ for IEEE 1394 Cameras gives you the ability to use IEEE 1394 industrial digital video cameras to acquire images. You can use cameras with the following output formats:

- Monochrome (8 bits/pixel)
- Monochrome (16 bits/pixel)
- RGB (24 bits/pixel)
- RGB (48 bits/pixel)
- YUV 4:1:1 (12 bits/pixel)
- YUV 4:2:2 (16 bits/pixel)
- YUV 4:4:4 (24 bits/pixel)
- Bayer (8 bits/pixel)
- Bayer (16 bits/pixel)

The cameras may operate at various resolutions and frame rates, depending on camera capabilities.

NI-IMAQ for IEEE 1394 Cameras complies with the 1394 Trade Association's Industrial and Instrumentation specification for Digital Cameras (IIDC) and controls all available modes of the digital camera.



Note Refer to the *NI-IMAQ for IEEE 1394 Cameras Release Notes* for the specific version of the IIDC specification to which this driver complies.

Application Development Environments

This release of NI-IMAQ for IEEE 1394 Cameras supports the following ADEs for Windows 2000/XP:

- LabVIEW version 7.0 and later
- LabVIEW Real-Time Module version 7.0 and later
- LabWindows™/CVI™ version 6.0 and later
- Microsoft Visual C/C++ version 6.0 and later
- Microsoft Visual Basic version 6.0 and later
- Microsoft Visual Studio .NET 2003 and later



Note Although the NI-IMAQ for IEEE 1394 Cameras software has been tested and found to work with these ADEs, other ADEs may also work.

Configuring a IEEE 1394 Camera

Use National Instruments Measurement & Automation Explorer (MAX) to configure your IEEE 1394 camera. Refer to the *NI-IMAQ for IEEE 1394 Cameras Help* for information about configuring your IEEE 1394 camera. You can access the *NI-IMAQ for IEEE 1394 Cameras Help* from within MAX by going to **Help»Help Topics»NI-IMAQ IEEE 1394**.

The camera configuration is saved in a camera file, which the NI-IMAQ for IEEE 1394 Cameras VIs and functions use to configure a camera and supported attributes.

Fundamentals of Building Applications with NI-IMAQ for IEEE 1394 Cameras

Architecture

Figure 1-1 illustrates the NI-IMAQ for IEEE 1394 Cameras driver architecture.

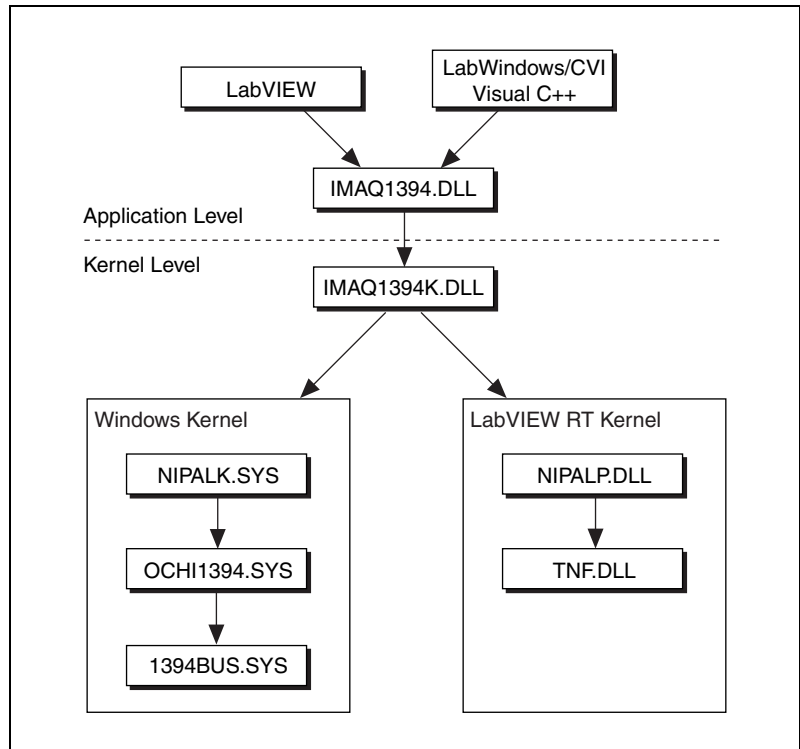


Figure 1-1. NI-IMAQ for IEEE 1394 Cameras Architecture

The architecture uses a *hardware abstraction layer*, which separates software API capabilities, such as general acquisition and control functions, from hardware-specific information. This layer lets you run your application on different operating systems and use updated versions of the driver without having to recompile your application.

NI-IMAQ for IEEE 1394 Cameras Libraries

The NI-IMAQ for IEEE 1394 Cameras function libraries are dynamic link libraries (DLLs), which means that NI-IMAQ for IEEE 1394 Cameras routines are not linked into the executable files of applications. Only the information about the NI-IMAQ for IEEE 1394 Cameras routines in the NI-IMAQ for IEEE 1394 Cameras import libraries is stored in the executable files.

Import libraries contain information about their DLL-exported functions. They indicate the presence and location of the DLL routines. Depending on the development tools you use, you can give the DLL routines

information through import libraries or through function declarations. Your NI-IMAQ for IEEE 1394 Cameras software contains function prototypes for all routines.

Example Programs

You can find NI-IMAQ for IEEE 1394 Cameras code examples in the following directories.



Note If you installed NI-IMAQ for IEEE 1394 Cameras in the default location, you can find the following example directories within `C:\Program Files\National Instruments`.

- **LabVIEW**—`LabVIEW\examples\imaq`. For a brief description of any example VI, open the VI, and select **Windows»Show VI Info** for a text description of the example.



Tip You can access the NI-IMAQ for IEEE 1394 Cameras examples from the NI Example Finder. From LabVIEW, go to **Help»Find Examples** to launch the NI Example Finder.

- **CVI**—`CVI\samples\imaq1394`.
- **C**—`NI-IMAQ for IEEE 1394\examples\MSVC`.
- **Visual Basic**—`NI-IMAQ for IEEE 1394\examples\VB`.
- **Microsoft Visual Studio .NET 2003**—`NI-IMAQ for IEEE 1394\examples\MSVB.NET`. The images for the examples are located in the `NI-IMAQ for IEEE 1394\examples\Images` directory. The .NET examples are converted from the NI-IMAQ for IEEE 1394 Cameras for Visual Basic examples. The .NET examples are written in Visual Basic .NET and demonstrate use of the NI-IMAQ for IEEE 1394 Cameras 2.0 Assemblies and the IMAQ Vision 7.1 Viewer control.

Refer to the `readme.rtf` file located in your target installation directory for the latest details about the example programs.

Basic Acquisition with NI-IMAQ for IEEE 1394 Cameras

This chapter contains an overview of the NI-IMAQ for IEEE 1394 Cameras library, a description of the acquisition flow of NI-IMAQ for IEEE 1394 Cameras, and generic programming examples. The chapter also contains flowcharts of high-level and low-level *snap*, *grab*, and *sequence* operations.

Introduction

The NI-IMAQ for IEEE 1394 Cameras application programming interface (API) is divided two main function groups: high-level and low-level.

- High-level functions—Use to capture images quickly and easily. If you need more advanced functionality, you can mix high-level functions with low-level functions.
 - Snap functions—Capture all or a portion of a single image to the *user buffer*.
 - Grab functions—Perform an acquisition that loops continually on one or more *internal buffers*. You can copy the last acquired buffer to a separate user buffer for processing or analysis.
 - Sequence functions—Acquire a specified number of internal buffers and then stops.
 - Trigger functions—Control the trigger mode of the IEEE 1394 camera.
- Low-level functions—Use when you require more direct control of the image acquisition.
 - Acquisition functions—Configure, start, stop, and unconfigure an image acquisition, or examine a user buffer during an acquisition.
 - Attribute functions—Examine and change the acquisition or camera attributes.
 - Utility functions—Display an image in a window, save an image to a file, or to get detailed error information.

Both high-level and low-level functions support snap, grab, sequence, and triggered acquisitions. Using high-level functions, you can write programs quickly without having to learn the details of the low-level API and driver. The low-level functions give you finer granularity and control over the image acquisition process, but you must understand the API and driver in greater detail to use these functions.



Note The high-level functions call low-level functions and use certain attributes that are listed in the high-level function description of the *NI-IMAQ for IEEE 1394 Cameras Function Reference Help*. Changing the value of these attributes while using low-level functions affects the operation of the high-level functions.

Acquisition Flow

This section describes the basic steps of performing an acquisition with the NI-IMAQ for IEEE 1394 Cameras software. The basic steps are initialization, configuration, and acquisition.

Initialization

To acquire images using the high-level or low-level functions, you first must initialize a *camera session*. A camera session is a *process-safe handle* to an IEEE 1394 camera. The driver uses a camera session to identify the camera to which further NI-IMAQ for IEEE 1394 Cameras functions apply. You can simultaneously open as many camera sessions as there are cameras connected to your system.

When initializing the camera session, you need to specify two parameters: camera name and camera control mode. Refer to the following sections for detailed information about these parameters. When an application is finished with the camera, call the Close function to close the camera session.

Camera Name

NI-IMAQ for IEEE 1394 Cameras references all camera sessions by a name. The driver creates default names for each camera in your system in the order that the cameras are connected. The names observe the convention shown in Table 2-1.

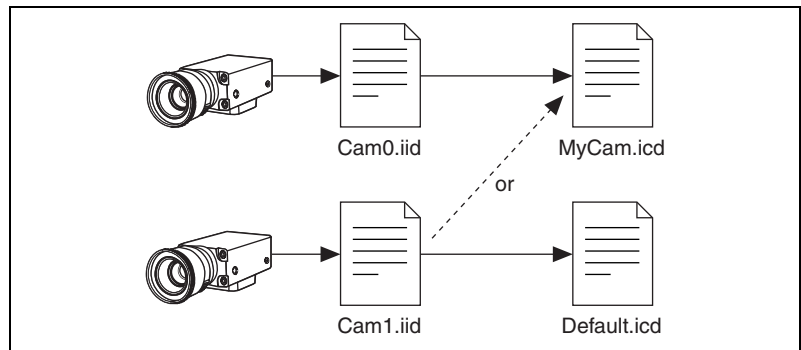
Table 2-1. Camera Naming Convention

Camera Name	IEEE 1394 Camera Installed
cam0	Device 0
cam1	Device 1
...	...
cam n	Device n

Every camera has an `.iid` interface file and an `.icd` camera file.

- Interface files—Store information about which physical camera is associated with a camera name. Each interface file can be used by only a single camera.
- Camera files—Store all the configurable attributes. Camera files can be shared between identical cameras. Use MAX to configure the default state of a particular camera.

Figure 2-1 shows the relationship between cameras, interface files, and camera files.

**Figure 2-1.** Relationship Between Cameras, Interface Files, and Camera Files

Note Use the Enumerate function to query the number and names of available cameras.

When you open a camera session with the Initialize function, the camera with the unique serial number described by the interface file `cam n .iid` opens, where n is the reference to the camera. If the camera is not present and a camera of the same make and model is present, as described in the interface file, the driver opens the available camera. The interface file updates to use the new camera. The camera file described by the interface

file opens, and all the user attributes are set in the driver. If no camera of the same make and model is present, the Initialize function returns an error.

Camera Control Mode

The camera control mode parameter has two options: controller and listener. The default option—controller—controls the camera and receives video data. The listener only receives video data. Use the listener option in broadcasting applications. Refer to the [Broadcasting](#) section of Chapter 3, *Advanced Programming with NI-IMAQ for IEEE 1394 Cameras*, for more information about broadcasting.

Configuration

After initializing the interface, configure the interface for acquisition by specifying the following parameters: whether the acquisition is one-shot or continuous, the number of internal buffers to use, and the region of interest for the acquisition.

During configuration, the driver validates all the user-configurable attributes. If any attributes are invalid or out of range, the driver returns an error and does not configure the acquisition.

If you want to reconfigure the acquisition, call the Clear Acquisition function before calling the Configure function again.



Note National Instruments recommends that you do *not* configure an acquisition in a loop because doing so is time-intensive.

One-Shot/Continuous Acquisition

Use a one-shot acquisition to start an acquisition, perform the acquisition, and stop the acquisition using a single function. The number of images acquired is equal to the number of images in the images collection.

With a one-shot acquisition, you specify a certain number of internal buffers. The camera transfers each image up to and including the specified number of buffers. The driver acquires every image during a one-shot acquisition. National Instruments recommends one-shot acquisition for applications that do not require real-time acquisition or processing.

Use a continuous acquisition to start an acquisition, continuously acquire images into the internal buffers, and explicitly stop the acquisition. With continuous acquisition, the driver acquires video data continuously from

the camera and enables you to examine the most current buffer. National Instruments recommends continuous acquisition for real-time acquisition and processing.



Note If CPU activity increases during a continuous acquisition, the driver might miss subsequent images. Check the buffer number output to determine if you have missed any images.

Number of Buffers

Another aspect of configuration is specifying the number of internal buffers into which you want to acquire image data. During configuration, buffers are allocated from system memory and page-locked. Once the acquisition starts, the camera transfers video data over the IEEE 1394 bus to the IEEE 1394 interface card *FIFO*. Then, video data is directly transferred to the internal buffer. This transfer requires negligible CPU resources.

Each internal buffer you allocate is the exact size of the raw data being transmitted by the camera. For continuous acquisitions, allocate three or more buffers. Allocating a single buffer for a continuous acquisition may result in a high number of lost images. For one-shot acquisitions, specify the number of buffers that the application requires. For example, if the application runs for two seconds, and the camera acquires at 30 frames per second, allocate 60 buffers to capture each image.

Region of Interest

The region of interest (*ROI*) specifies a rectangular portion of the image to be captured. In Partial Image Size Format (Format 7) video modes, the ROI defines the portion of the image to transfer from the camera to system memory. In non-Format 7 video modes, the entire image is transferred from the camera to system memory. In all video modes, the ROI specifies the amount of data decoded by the driver while acquiring into a user buffer.

By default, the driver transfers the entire image. Specify a smaller ROI for the following reasons:

- To acquire only the necessary subset of data
- To increase the acquisition speed by reducing the amount of data transferred and/or decoded
- To allow for multiple simultaneous acquisitions by reducing bandwidth usage



Note Although you can specify an ROI of any size, the NI-IMAQ for IEEE 1394 Cameras software coerces the ROI into one that is more compatible for the given camera. Refer to Chapter 3, *Advanced Programming with NI-IMAQ for IEEE 1394 Cameras*, for more information about defining an ROI for Format 7 images.

Acquisition

After configuring and starting your acquisition, the camera sends data to the internal buffers. To process the acquired image data, you must copy the data from the internal buffer into your user buffer.

User Buffer

Before starting the acquisition, you must allocate a user buffer in addition to configuring internal buffers. The driver copies or decodes image data from the internal buffer into the user buffer during acquisition. Then, process and analyze the image in the user buffer.

When acquiring data into an IMAQ Vision image, the driver resizes and casts the image as needed. However, if you acquire data into a user buffer, you must allocate enough space for one decoded image.



Note Unlike internal buffers, you are responsible for destroying user buffers.

Buffer Number

A buffer number is a zero-based index that represents the cumulated transferred image count. For example, during a continuous acquisition with three internal buffers, the buffer number is updated as follows: 0, 1, 2, 3, 4, 5, and so on. Buffer numbers 0 and 3 refer to the same internal buffer in the buffer ring.

For a one-shot acquisition, you can request only one of the available buffer numbers. For a continuous acquisition, you can request any present or future buffer number. You can also request the next logical buffer or the buffer containing the most recently acquired data. With high-level grab acquisitions, the buffer number defaults to the next transferred buffer.

When you complete the buffer acquisition step, the driver returns the actual buffer number with the image.

Overwrite Mode

Ideally, a continuous acquisition acquires and processes every image that is transferred from the camera. However, because of processing time fluctuations, some images from the camera may not be processed before the camera transfers the next image. Using multiple internal buffers in a continuous acquisition allows for a small amount of jitter. However, if a delay becomes too long, the camera overwrites the requested buffer with new image data.

NI-IMAQ for IEEE 1394 Cameras is able to detect overwritten internal buffers. You can configure the driver to manage an overwritten buffer in one of the following ways:

- Get newest valid buffer
- Get oldest valid buffer
- Fail and return an error

In all cases, the camera continues to transfer data when a buffer is overwritten.

The default overwrite mode for all types of acquisition is to get the newest valid buffer. This option, which National Instruments recommends for most applications, enables you to process the most recent image. If you need to get the image closest in time to a requested buffer, configure the driver to get the oldest valid buffer. If your application requires that every image be processed, configure the driver to fail when a buffer is overwritten so that you are alerted.

Timeouts

A *timeout* is the length of time, in milliseconds, that the driver waits for an image from the camera before returning an error. A timeout error usually occurs if the camera has been removed from the system or when the camera did not receive an external trigger signal.

Decoding

Except for 8-bit monochrome images, all video modes require decoding before you can interpret the image data. For example, many color IEEE 1394 cameras output images of type YUV 4:2:2. However, IMAQ Vision does not natively support the YUV mode. To process and display the image, the driver automatically decodes the YUV image into a 32-bit RGB image.

Table 2-2 lists common video modes and their corresponding image types after being decoded by NI-IMAQ for IEEE 1394 Cameras.

Table 2-2. Decoder Inputs and Corresponding Outputs

Raw Camera Output	Decoded Destination Image
8-bit monochrome	8-bit monochrome
16-bit monochrome (<i>big endian</i>)	16-bit monochrome (<i>little endian</i>)
YUV 4:1:1	32-bit color
YUV 4:2:2	32-bit color
YUV 4:4:4	32-bit color
24-bit RGB	32-bit color
48-bit RGB	64-bit color
8-bit Bayer	32-bit color
16-bit Bayer	32-bit color

Decoding images requires CPU resources. However, many of the decoding algorithms have been optimized in the driver. If you do not want decoded image data, you can use NI-IMAQ for IEEE 1394 Cameras to get a copy of the raw camera output.

Programming Examples

This section contains examples of high-level and low-level image acquisitions. Refer to the [Example Programs](#) section of Chapter 1, [Introduction to NI-IMAQ for IEEE 1394 Cameras](#), for directory paths to the code examples discussed in this section.

High-Level Function Examples

Use high-level functions to write programs quickly without having to learn the details of the low-level API and driver.

Snap

A snap acquires a single image into a user buffer. Figure 2-2 illustrates the typical programming order of a high-level snap acquisition.

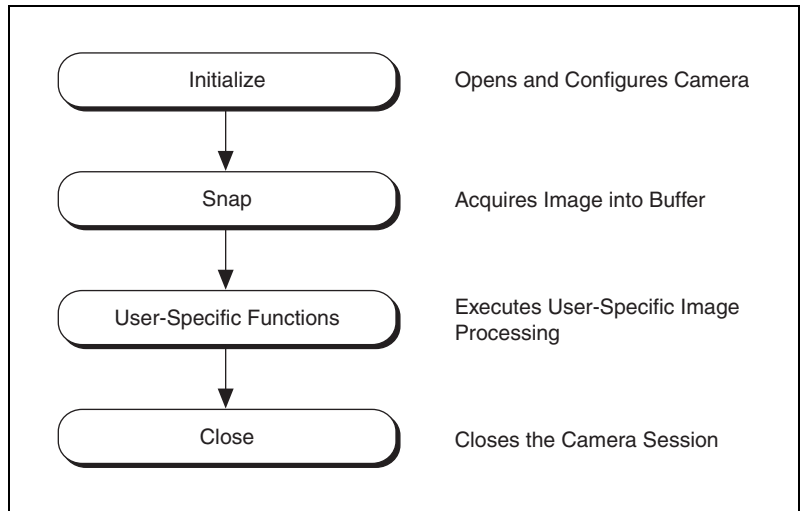


Figure 2-2. High-Level Snap Flowchart

Use a snap for low-speed or one-shot applications where ease of programming is essential. When you invoke a snap, the driver opens a session on a camera and initializes the IEEE 1394 camera. Opening a session sets the ROI to the size of the video mode you selected in MAX.



Note If you do not have a valid session, a temporary session is created using `cam0`.

Then, the snap acquires the next incoming image into a user buffer. After the image is acquired, the program calls image processing and analysis functions. When the processing and analysis functions are finished, the program calls the Close function using the camera handle. This function instructs NI-IMAQ to free all of the resources associated with this camera, which releases the session.

Grab

A grab initiates a continuous high-speed acquisition of images to one or more internal buffers. Figure 2-3 illustrates the typical programming order of a high-level grab acquisition.

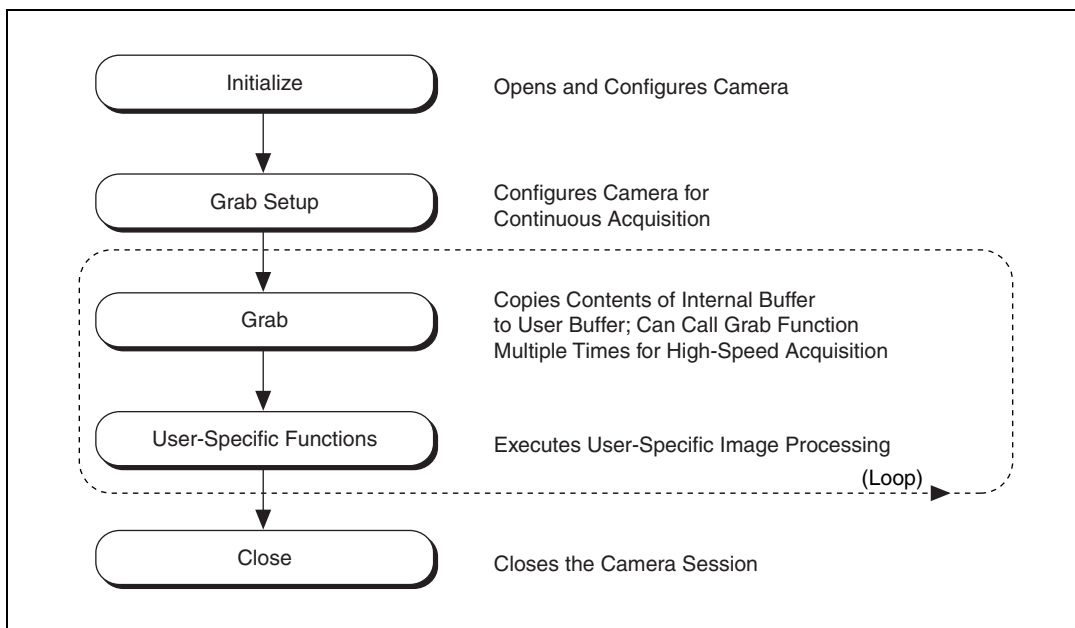


Figure 2-3. High-Level Grab Flowchart

Use a grab for high-speed applications during which you need to process only one image at a time. You can copy the last acquired buffer to a separate user buffer for processing or analysis. To use these functions, you must have a valid session. If you do not have a valid session, the NI-IMAQ for IEEE 1394 Cameras Grab Setup function creates a session using `cam0`.

Calling the Grab Setup function initializes a session for a grab acquisition. During acquisition, each successive grab copies the last acquired internal buffer into a user buffer where you can process the image.

Sequence

A sequence acquires a specified number of internal buffers and then stops. Figure 2-4 illustrates the typical programming order of a high-level sequence acquisition.

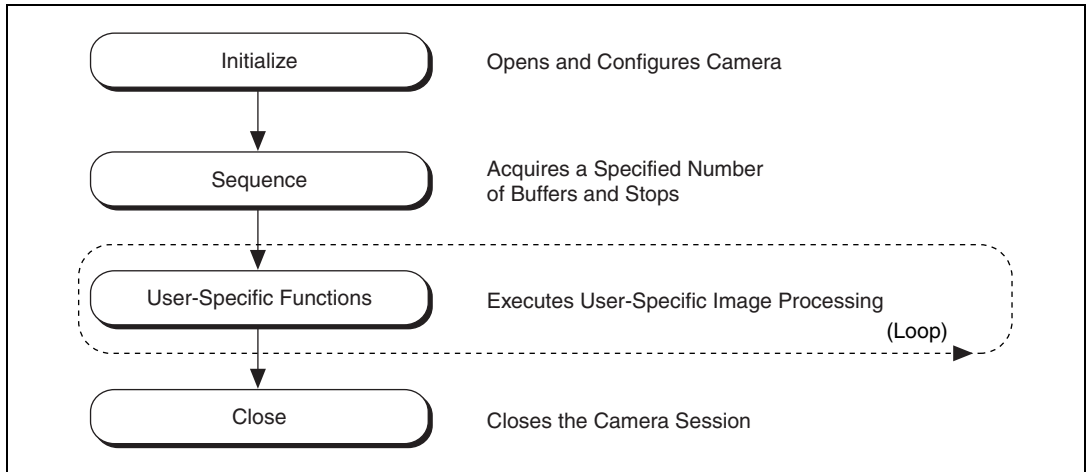


Figure 2-4. High-Level Sequence Flowchart

Use a sequence in applications where you need to process a series of consecutive images. Sequence acquisitions are synchronous. If you do not specify a session, a temporary session is created using `cam0`.

Low-Level Function Examples

Use low-level functions for more advanced programming techniques. In general, low-level functions have more parameters than high-level functions.

Snap

The low-level snap examples set up a one-shot, single-image acquisition and start the acquisition. The program acquires an image and processes it. Finally, the program stops the acquisition, unconfigures the acquisition, and closes the session.

Figure 2-5 illustrates the programming order of a low-level snap acquisition.

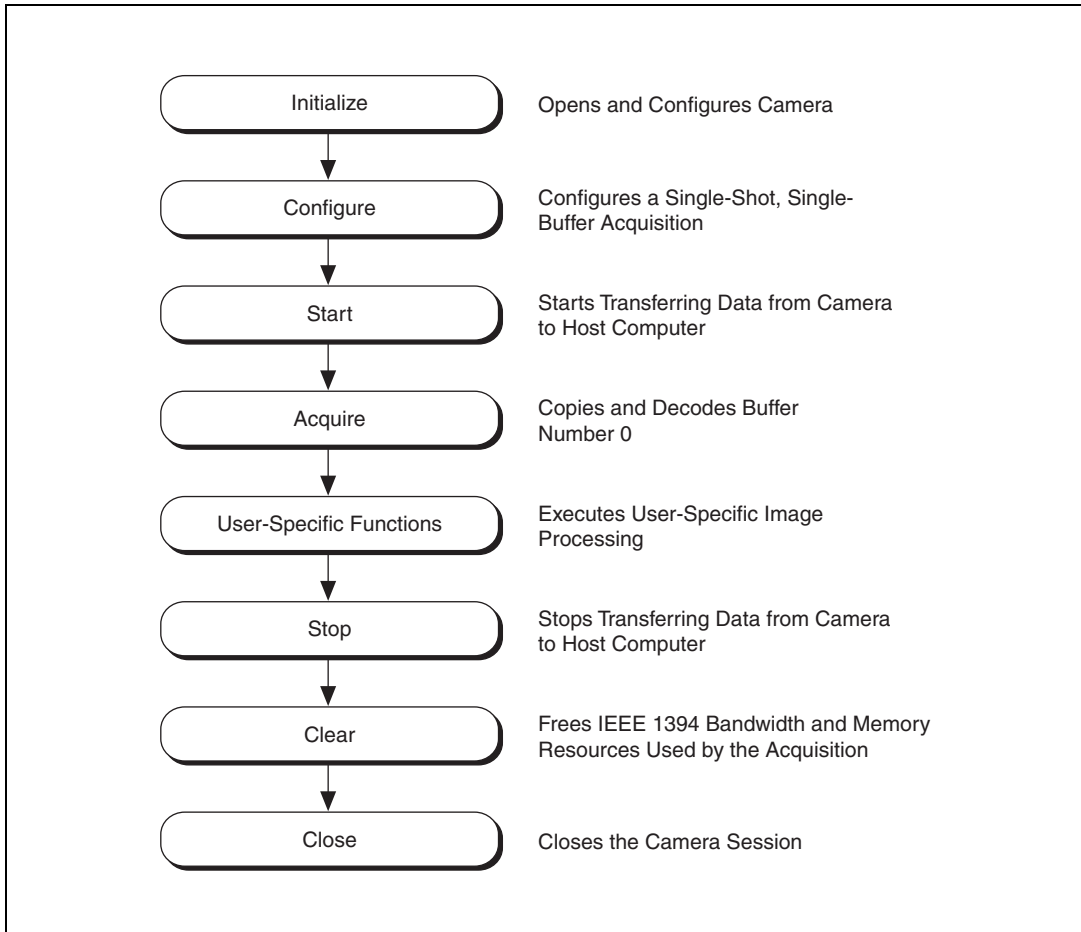


Figure 2-5. Low-Level Snap Flowchart

Grab

The low-level grab examples demonstrate how to perform a grab acquisition using low-level function calls. The program sets up a continuous acquisition into three internal buffers and starts the acquisition. The main loop iterates continuously. In the main processing loop, the program acquires an image and processes it. After the loop, the program stops the acquisition, unconfigures the acquisition, and closes the session.

Figure 2-6 illustrates the programming order of a low-level grab acquisition.

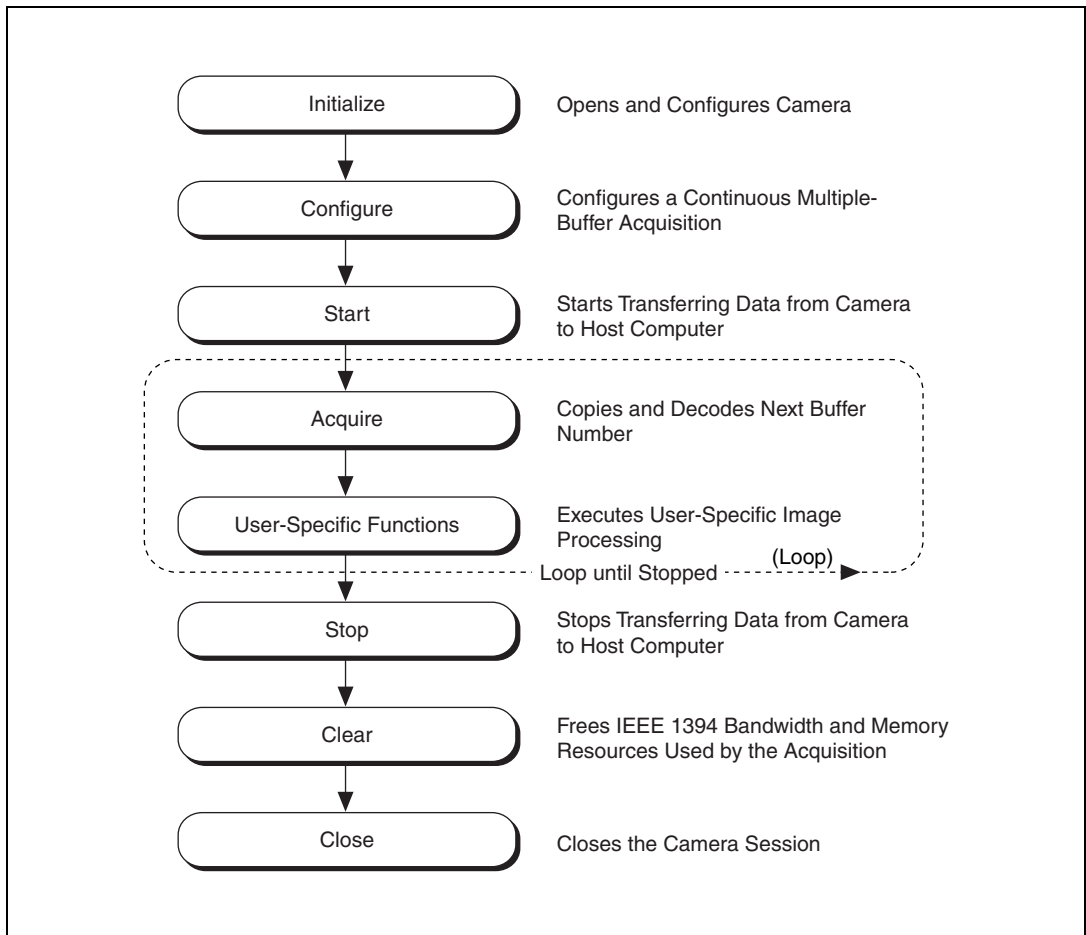


Figure 2-6. Low-Level Grab Flowchart

Sequence

The low-level sequence examples demonstrate how to perform a sequence acquisition using low-level calls. The program sets up a one-shot, multi-image acquisition and starts the acquisition. The main loop iterates once for each internal buffer. In the main processing loop, the program acquires an image and processes it. After the loop, the program stops the acquisition, unconfigures the acquisition, and closes the session.

Figure 2-7 illustrates the programming order of a low-level sequence acquisition.

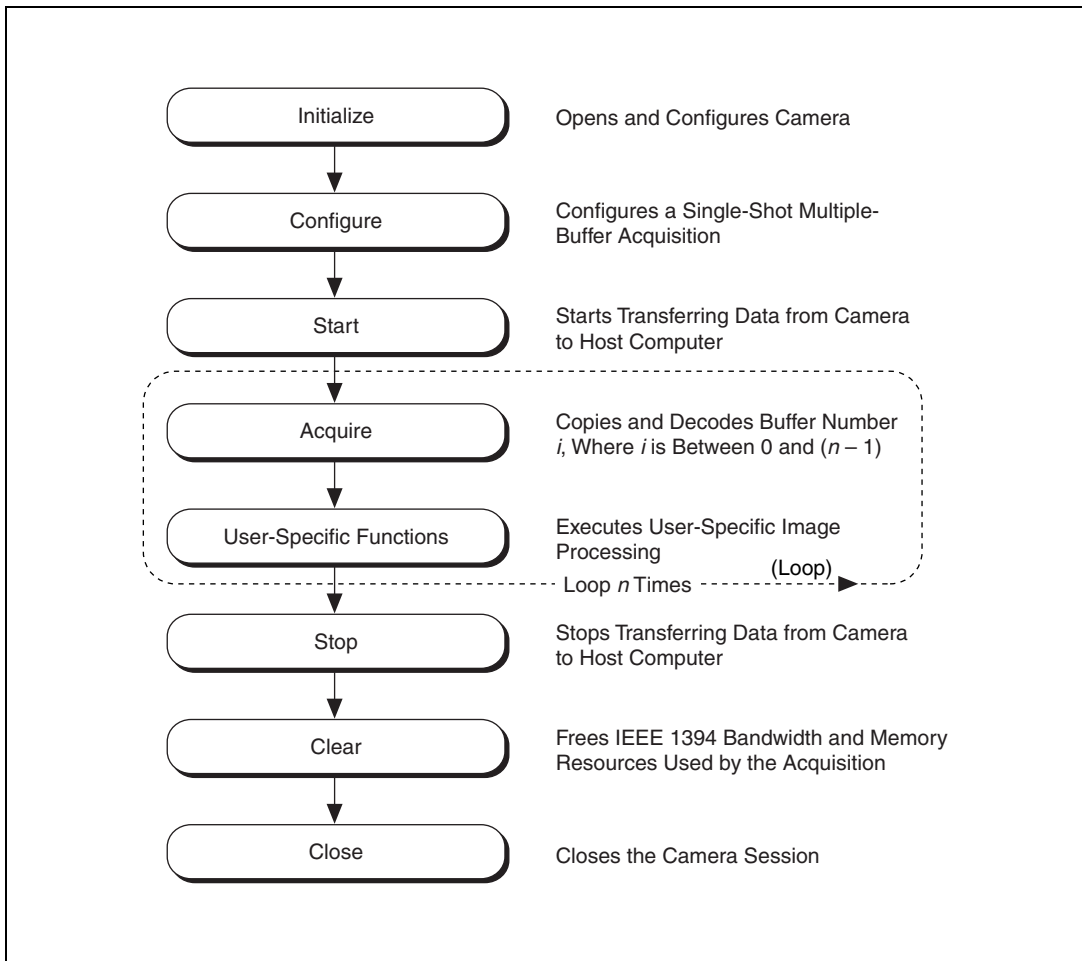


Figure 2-7. Low-Level Sequence Flowchart

Advanced Programming with NI-IMAQ for IEEE 1394 Cameras

This chapter contains information about setting camera attributes, broadcasting acquired images to multiple machines, using Format 7 to define the size of transferred images, and triggering.

Camera Attributes

Use camera attributes to control camera-specific features, such as brightness and shutter speed. You can set camera attributes directly from the NI-IMAQ for IEEE 1394 Cameras software or through the **Camera Attributes** tab in MAX.

The following attributes are defined in the *1394 Based Digital Camera Specification*—brightness, auto exposure, sharpness, white balance, hue, saturation, gamma, shutter, gain, iris, focus, temperature, zoom, pan, tilt, optical filter, trigger delay, frame rate prioritize, and white shading.

The LabVIEW, C, Visual Basic, and .NET APIs all provide Get Attribute and Set Attribute functions to modify camera attributes. However, supported attributes are camera specific. Refer to your camera documentation for information about the attributes your camera supports. If your camera does not implement every attribute specified, the functions return an error.

Broadcasting

Many machine vision applications involve a single host computer acquiring data from a single industrial camera. Other machine vision applications acquire data from multiple industrial cameras concurrently. With the broadcasting feature, a machine vision application can run on multiple host computers while acquiring data from a single camera, as shown in Figure 3-1.

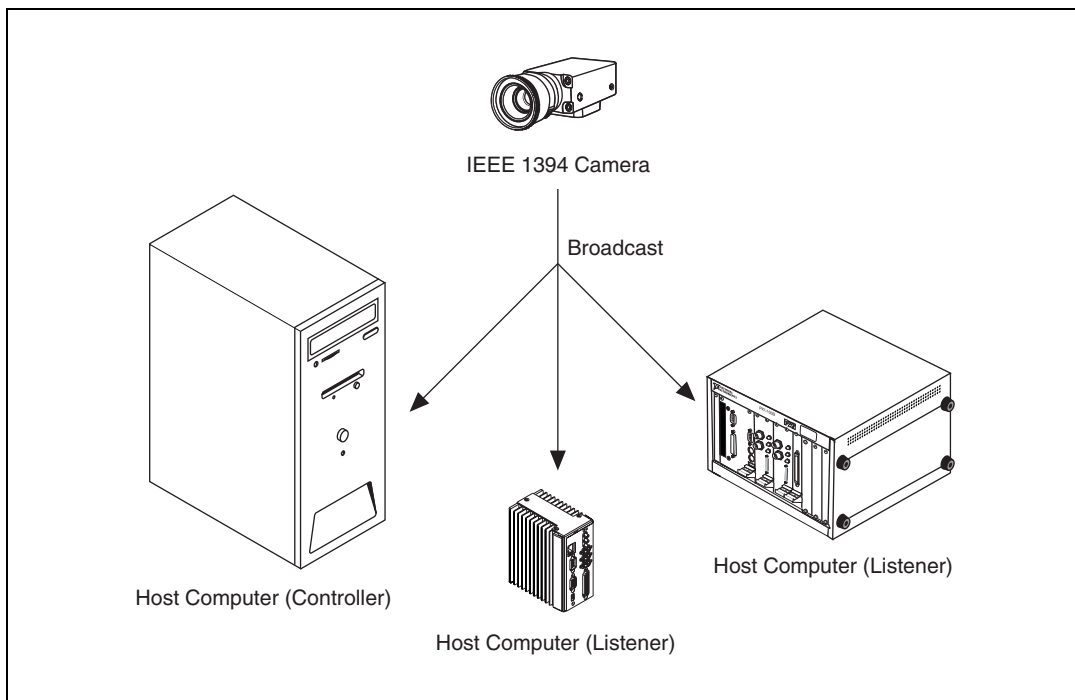


Figure 3-1. One Camera Broadcasting to Multiple Host Computers

The IEEE 1394 camera broadcasts video data on the IEEE 1394 bus and all the connected host computers receive the same image data. In this scenario, one host computer is designated as the controller. The controller is responsible for starting/stopping the camera feed. There can be only one controller per camera. The listeners obtain image data from the IEEE 1394 bus. The listeners do not control the camera in any way. There may be one or more listeners per camera.

Broadcasting has many uses. Computationally intensive tasks can be spread across different machines, thus effectively distributing computations. Multiple host computers can also perform redundancy checks. Additionally, listeners can monitor the current status of a headless system.

Implementation

Usage for the controller is unchanged from a stand-alone application. Open your camera interface with the default interface name (for example, `cam0`) configured in MAX. Configure and start your acquisition.

Next, start the listener(s). On the listening computer, open your camera interface with the 64-bit unique identifier of the target camera, which you can find in the **General** tab in MAX. The controller can get a unique ID and send it to the listener sessions. Additionally, you must set the listener camera control mode parameter.

At this point, both the controller and listener systems are acquiring the same live data from the same camera. When running as a listener, most attributes—such as the camera features, video modes, or Format 7 acquisition parameters—are read-only. No camera feature or control is accessible when running as a listener system. Attempts to set these attributes result in the following error: Attribute not writable.

There is no synchronization between the controller and the listener host computers provided by the low-level driver. The user must start the controller before starting the listener. If the camera is not transmitting data when the listener initializes, the session returns the following error: No acquisition in progress. If the controller stops the video feed of the camera, the listener times out.

Scalable Image Size

IEEE 1394 digital cameras support a predefined set of image sizes, which you can select through the **Video** attributes in MAX. Refer to your camera documentation for a list of supported formats.

If you are using LabVIEW, the NI-IMAQ for IEEE 1394 Cameras software recognizes the predefined formats and automatically allocates enough memory to accommodate the image. If you use C or C++ with NI-IMAQ for IEEE 1394 Cameras functions, you must know the size of the image for the selected format and mode to allocate enough memory to contain the image. Obtain the size of the image using the **Image Width**, **Image Height**, and **BytesPerPixel** attributes.

Some IEEE 1394 cameras support Format 7, which allows you to define the size of the acquired image. If you use this format, you must input the image size using the **Rectangle** parameter in C and C++. The size and position of the sub-image you are acquiring must be a multiple of the attributes **Unit Width** and **Unit Height**, as shown in Figure 3-2, or the driver acquires the smallest sub-image that contains the ROI you defined.

The **Unit Width** and **Unit Height** values are camera-specific. Refer to the camera documentation or query the **Unit Width** and **Unit Height** attributes to obtain the actual values.

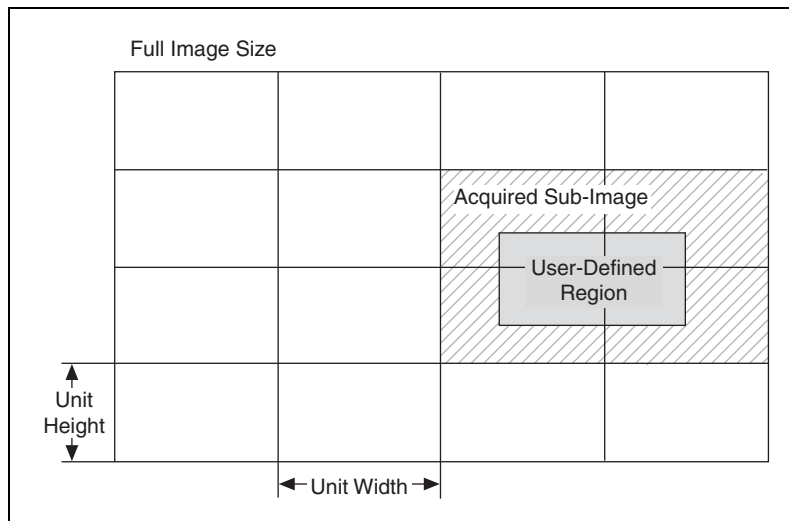


Figure 3-2. Partial Image Size Format (Format 7)

Trigger Modes

The IIDC 1.31 specification provides several external triggering modes for IEEE 1394 cameras. A IEEE 1394 camera may support one or more of the triggering modes. Refer to your camera documentation to find out which standard modes are implemented.

All of the NI-IMAQ for IEEE 1394 Cameras ADEs have a Trigger Configure function. The Trigger Configure function has the following input parameters:

- **Polarity**—Specifies when the trigger input is active. A value of TRUE indicates that the trigger is considered active when the value is high. The default value depends on the vendor implementation of the IEEE 1394 camera.
- **Timeout**—Maps to the acquisition timeout attribute. Use this parameter to specify the amount of time to wait for a trigger before issuing a timeout error. Specify a timeout duration that is at least as long as the cycle time of the slowest expected frame rate.
- **Mode**—Specifies one of the trigger modes described in the following sections.
- **Optional**—Certain trigger modes require an additional parameter. Refer to the following sections to see if the optional parameter is required.

Trigger Mode 0

With trigger mode 0, the camera starts frame integration when the external trigger input changes to an active value. The frame is exposed for a duration specified by the shutter attribute before the camera transfers the image to the host computer. No optional parameter is required.

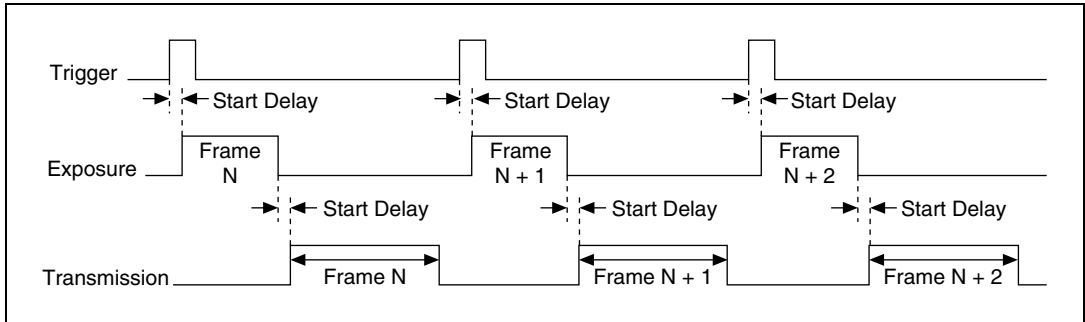


Figure 3-3. Timing Diagram for Trigger Mode 0

Trigger Mode 1

With trigger mode 1, the camera starts frame integration when the external trigger input changes to an active value. The frame is exposed while the external trigger is active. When the trigger becomes inactive, the camera stops frame integration and transfers the image to the host computer. No optional parameter is required.

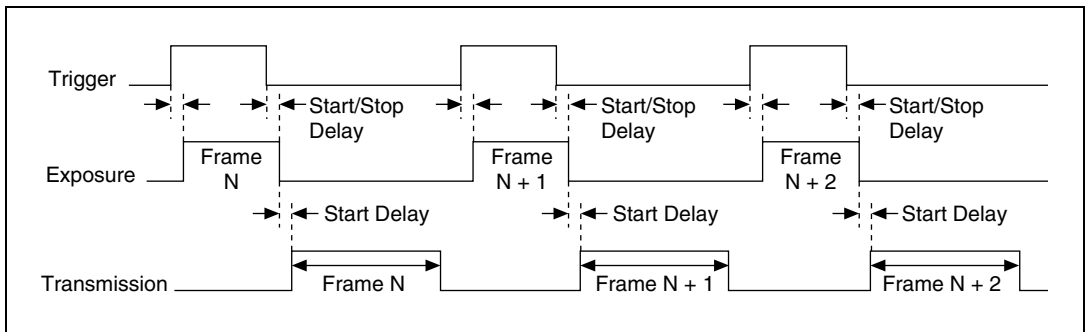


Figure 3-4. Timing Diagram for Trigger Mode 1

Trigger Mode 2

With trigger mode 2, the camera starts frame integration when the external trigger input changes to an active value. The same frame is exposed for multiple triggers. The number of triggers is specified by the optional parameter, which must have a value of 2 or more.

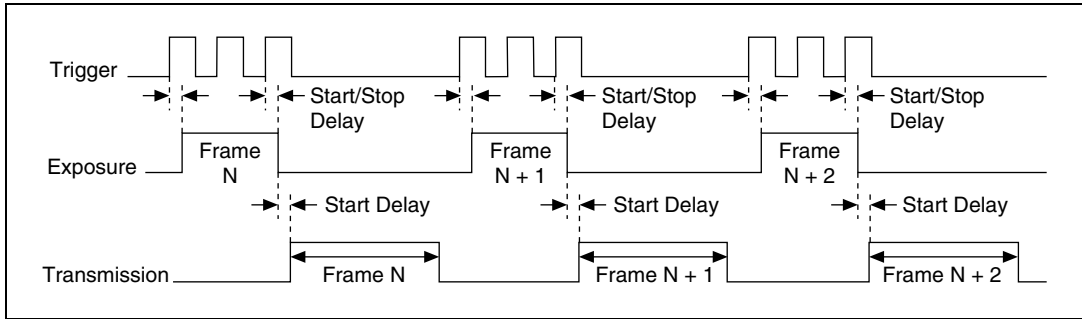


Figure 3-5. Timing Diagram for Trigger Mode 2

Trigger Mode 3

With trigger mode 3, the camera triggers continuously internally. The frame is exposed for a duration specified by the shutter attribute before the camera transfers the image to the host computer. The next internal trigger becomes active after a set cycle time. The cycle time is N times the cycle time of the fastest frame rate. N is specified by the optional parameter, which must have a value of 1 or more.

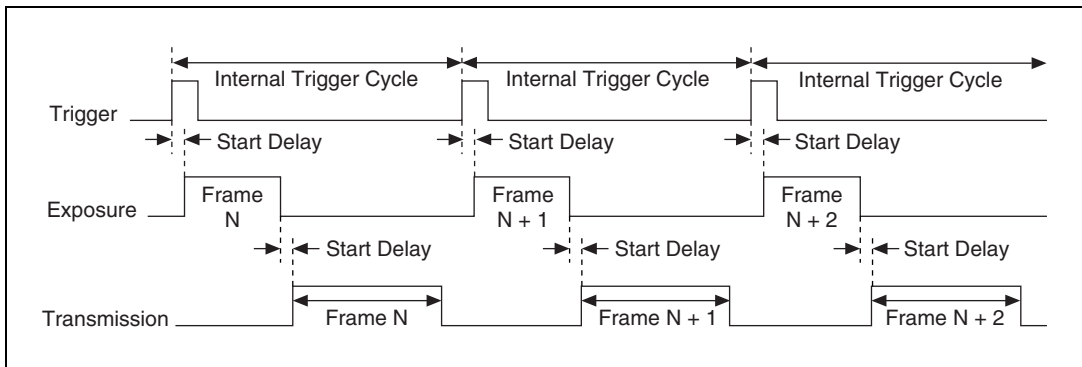


Figure 3-6. Timing Diagram for Trigger Mode 3

Trigger Mode 4

With trigger mode 4, the camera starts frame integration when the external trigger input changes to an active value. Multiple frames are exposed before the camera transfers the image to the host computer. Each frame is exposed for a duration specified by the shutter attribute. The number of frames is specified by the optional parameter, which must have a value of 1 or more.

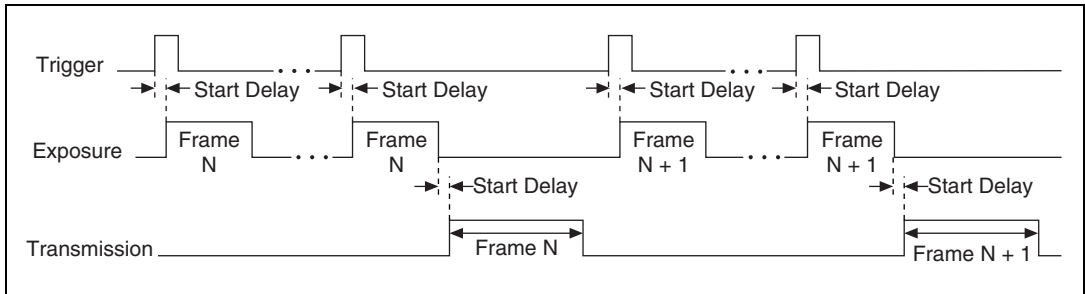


Figure 3-7. Timing Diagram for Trigger Mode 4

Trigger Mode 5

With trigger mode 5, the camera starts frame integration when the external trigger input changes to an active value. Multiple frames are exposed before the camera transfers the image to the host computer. Each frame is exposed while the external trigger is active. The number of frames is specified by the optional parameter, which must have a value of 1 or more.

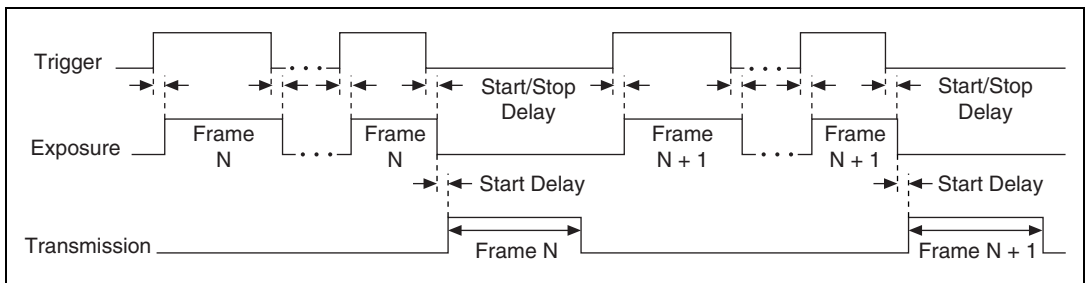


Figure 3-8. Timing Diagram for Trigger Mode 5

Using NI-IMAQ for IEEE 1394 Cameras in LabVIEW

This chapter describes how to use NI-IMAQ for IEEE 1394 Cameras VIs in LabVIEW.

Introduction

The NI-IMAQ for IEEE 1394 Cameras VI library—part of the NI-IMAQ for IEEE 1394 Cameras software—is a group of virtual instruments (VIs) that enable you to use LabVIEW with an IEEE 1394 camera.

IMAQ Vision for LabVIEW is the National Instruments image processing and analysis library, which consists of more than 400 VIs. Some of the basic IMAQ Vision VIs are shared with NI-IMAQ for IEEE 1394 Cameras. If you do not have IMAQ Vision, you can use the IMAQ Vision VIs included with NI-IMAQ for IEEE 1394 Cameras to create an image acquisition application. When you use these basic VIs, you can upgrade your application later to use additional IMAQ Vision VIs without making changes to your initial image acquisition application.

NI-IMAQ for IEEE 1394 Cameras adds a subpalette of VIs to the **Vision** Functions palette and an Image Display control to the Controls palette.

Create NI-IMAQ for IEEE 1394 Cameras applications as you would any other LabVIEW or LabVIEW Real-Time (RT) application. Drop icons onto the block diagram to create the program, and use the front panel to design the user interface. Click **Run** to compile and run the application.

Before you start building an image acquisition application, familiarize yourself with the basic knowledge and concepts contained in the following sections.

Location of the NI-IMAQ for IEEE 1394 Cameras VIs

You can find the NI-IMAQ for IEEE 1394 Cameras VIs in the LabVIEW **Functions** palette. From the LabVIEW block diagram, select **NI Measurements»Vision»IMAQ IEEE-1394**.

The most commonly used, high-level VIs are on the **IMAQ for IEEE-1394** palette. You can find VIs for basic acquisition and changing attributes. The **Vision»IMAQ for IEEE-1394»IMAQ IEEE-1394 Low Level** palette contains VIs for more advanced applications.

Refer to the *NI-IMAQ for IEEE 1394 Cameras VI Reference Help* for more information about using these VIs.

Common VI Parameters

The following sections describe commonly used VIs and important parameters common to many VIs.

IMAQ1394 Session

IMAQ1394 Session is a unique identifier that specifies which interface file to use for the acquisition. The IMAQ1394 Session is produced by the IMAQ1394 Init VI and used as an input to all other NI-IMAQ for IEEE 1394 Cameras VIs. The NI-IMAQ for IEEE 1394 Cameras VIs use IMAQ1394 Session Out, which is identical to IMAQ1394 Session, to simplify dataflow programming. IMAQ1394 Session Out is similar to the duplicate file sessions provided by the file I/O VIs. The high-level acquisition VIs—IMAQ1394 Snap, IMAQ1394 Grab Setup, and IMAQ1394 Sequence—require you to wire IMAQ1394 Session In only in the following instances:

- If you are using an interface other than the default `cam0`
- If you are using multiple cameras
- If you need to set IMAQ 1394 properties before the acquisition

To get and set properties of the acquisition and camera, wire the IMAQ1394 Session to the LabVIEW property node.

Image Buffer

Many acquisition VIs require an image buffer to receive the captured image. You can create this image buffer with IMAQ Create. Refer to the [Buffer Management](#) section of this chapter for more information about using buffers. **Image In** receives the image buffer. **Image Out** returns the captured image.

Region of Interest

The acquisition VIs use the **Region of Interest** input to specify a rectangular portion of an image frame to be captured. You can use **Region of Interest** to reduce the size of the image you want to capture. **Region of Interest** is an array of four elements whose elements are defined as **Left**, **Top**, **Right**, and **Bottom**. If **Region of Interest** is not wired, the entire image acquisition window is captured. Configure the default acquisition window using MAX.

Acquisition VIs

Two types of acquisition VIs are available in LabVIEW: high-level and low-level.

High-Level

Use the high-level acquisition VIs for basic image acquisition applications. VIs are included for snap, grab, and sequence, as described in the [Acquisition Types](#) section of this chapter.

Low-Level

Use the low-level acquisition VIs for more advanced image acquisition applications. The low-level VIs configure an acquisition, start an acquisition, retrieve the acquired images, and stop an acquisition. You can use these VIs to construct advanced IMAQ applications.

Complete the following general steps to perform a low-level acquisition.

1. Call IMAQ1394 Init to initialize the board and create an IMAQ1394 Session.
2. Call IMAQ1394 Configure Acquisition to allocate resources for the acquisition.
3. Call IMAQ1394 Start Acquisition to start transferring data from the camera.

4. Call IMAQ1394 Get Image to obtain a copy of the requested image data.
5. After an acquisition, call IMAQ1394 Stop Acquisition to stop transferring data from the camera.
6. Call IMAQ1394 Clear Acquisition to release the resources associated with the acquisition.
7. Call IMAQ1394 Close to close the camera session.



Note If an acquisition is in progress and you call IMAQ1394 Close, the driver automatically stops the acquisition and releases resources associated with the acquisition.

Buffer Management

The IMAQ Create VI and IMAQ Dispose VI manage image buffers in LabVIEW.

IMAQ Create, shown in Figure 4-1, allocates an image buffer. **Image Name** is a label for the buffer created. Each buffer must have a unique name. **Image Type** specifies the type of image being created. Use **Grayscale (U8)** for 8-bit monochrome images, **Grayscale (U16)** for 16-bit monochrome images, and **RGB (U32)** for RGB color images.



Note If **Image Type** is set to a value incompatible with the current video mode, NI-IMAQ for IEEE 1394 Cameras automatically changes the value to a compatible one when acquiring images.

New Image contains pointer information to the buffer, which is initially empty. When you wire **New Image** to the **Image in** input of an image acquisition VI, the image acquisition VI allocates the correct amount of memory for the acquisition. If you are going to process the image, you might need to provide a value for **Border Size**. **Border Size** is the width, in pixels, of a border created around an image. Some image processing functions, such as labeling or morphology, require a border.

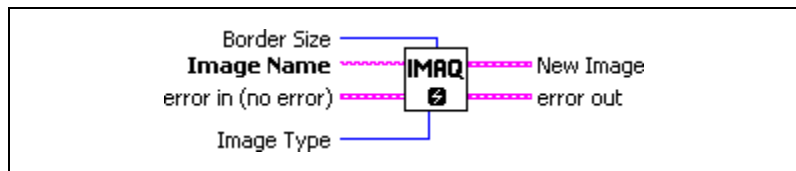


Figure 4-1. IMAQ Create

IMAQ Dispose, shown in Figure 4-2, frees the memory allocated for the image buffer. Call this VI only after the image is no longer required for processing.

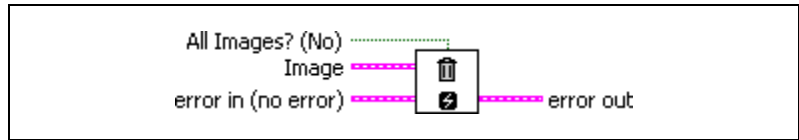


Figure 4-2. IMAQ Dispose

Acquisition Types

The following sections describe snap, grab, and sequence acquisitions in LabVIEW and give examples.

Snap

Use the IMAQ1394 Snap VI for snap applications. Figure 4-3 shows a simplified block diagram for using IMAQ1394 Snap.

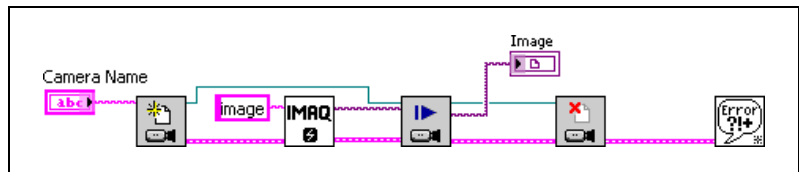


Figure 4-3. Acquiring an Image Using Snap

Grab

Use two VIs—IMAQ1394 Grab Setup and IMAQ1394 Grab Acquire—for a grab acquisition in LabVIEW. Call IMAQ1394 Grab Setup once to initialize the acquisition and start capturing the image to an internal software buffer. You can call IMAQ1394 Grab Acquire multiple times to copy the image currently stored in the internal buffer to a LabVIEW image buffer. After the program finishes copying images, call IMAQ1394 Close once to shut down the acquisition.

Figure 4-4 shows a simplified block diagram for using IMAQ1394 Grab Setup and IMAQ1394 Grab Acquire.

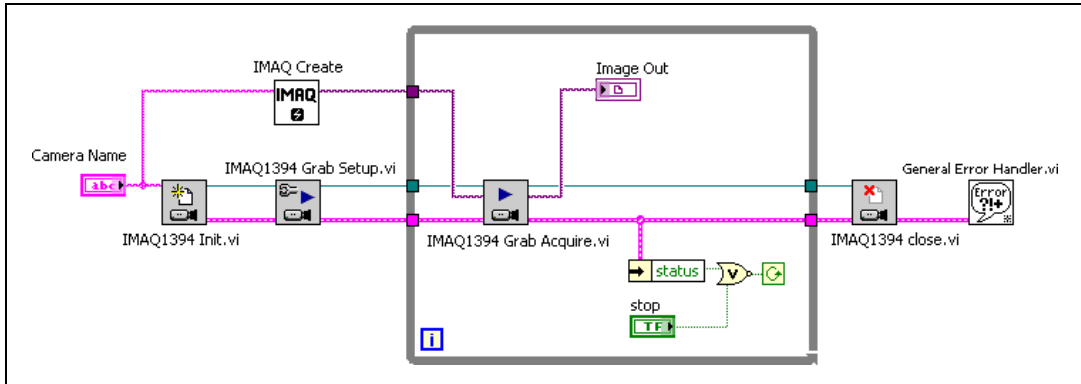


Figure 4-4. Acquiring Images Using Grab

Sequence

Use the IMAQ1394 Sequence VI for sequence applications. IMAQ1394 Sequence starts, acquires, and releases a sequence acquisition. IMAQ1394 Sequence does not return until the entire sequence is acquired.

Figure 4-5 shows a simplified block diagram for using IMAQ1394 Sequence. Place the IMAQ Create VI inside a For Loop to create an array of images for the **Image In** input to IMAQ1394 Sequence. The Number to Decimal String VI and Concatenate String VI create a unique name for each image in the array.

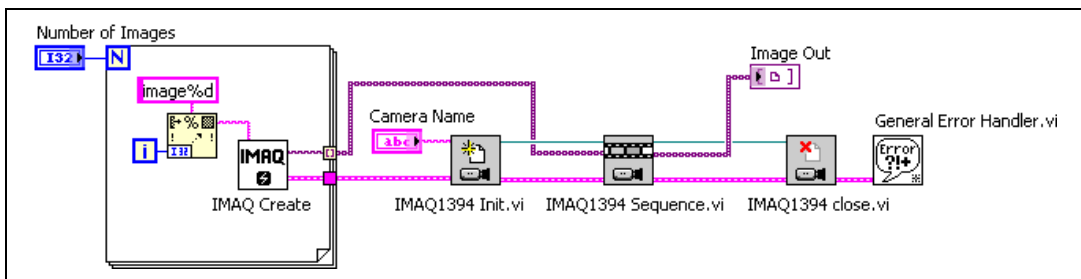


Figure 4-5. Acquiring Images Using Sequence

Triggering

Often, you may need to link or coordinate a vision action or function with events external to the computer, such as receiving a strobe pulse for lighting or a pulse from an infrared detector that indicates the position of an item on an assembly line. In these cases, use a triggered image acquisition.

Figure 4-6 illustrates using the IMAQ1394 Configure Trigger VI to perform a grab acquisition based on a trigger. **Timeout** specifies the amount of time, in milliseconds, to wait for the trigger.

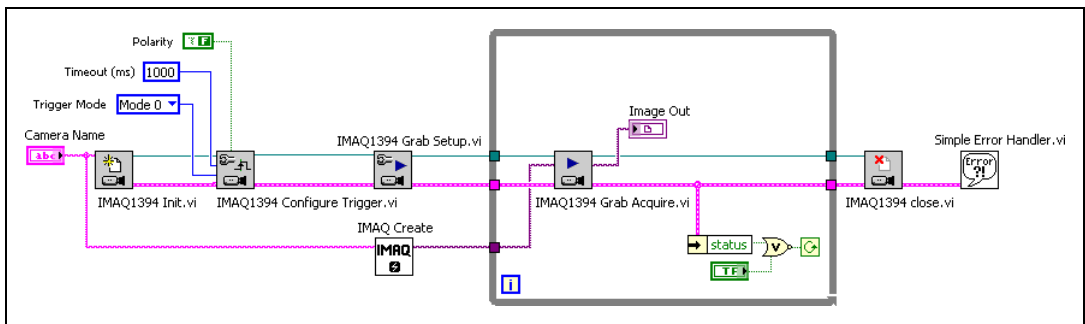


Figure 4-6. IMAQ Triggering

Image Display

Many image acquisition applications require that one or more images be displayed. You have several options for displaying images in LabVIEW.

You can display an image directly on the front panel using an Image Display control, which is available on the **Vision** Controls palette. To display an image on an Image Display control, place the control on the front panel of your VI. On the block diagram, wire **Image Out** from an acquisition VI to the Image Display control terminal.

Figure 4-7 illustrates using an image control to display an image using an Image Display control. For more information about Image Display controls, refer to the *IMAQ Vision for LabVIEW VI Reference Help*.

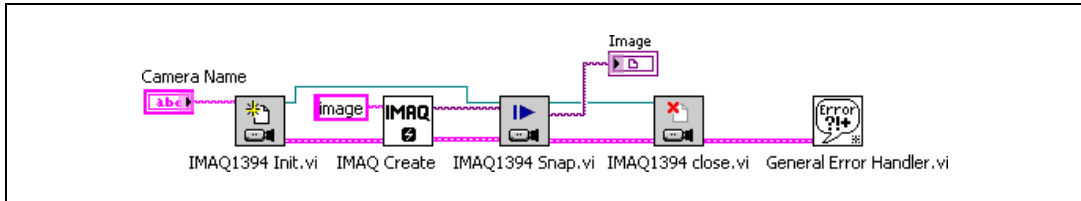


Figure 4-7. Displaying an Image Using an Image Control

If you have IMAQ Vision for LabVIEW, you can display an image in an external window using IMAQ WindDraw, located at **Vision»Vision Utilities»External Display**. Use IMAQ WindDraw when you need more image size and location control.

Figure 4-8 illustrates using IMAQ WindDraw to display an image acquired using IMAQ1394 Snap. You can display images in the same way using any acquisition type. For more information about the display capabilities of IMAQ Vision, refer to the *IMAQ Vision for LabVIEW User Manual*.

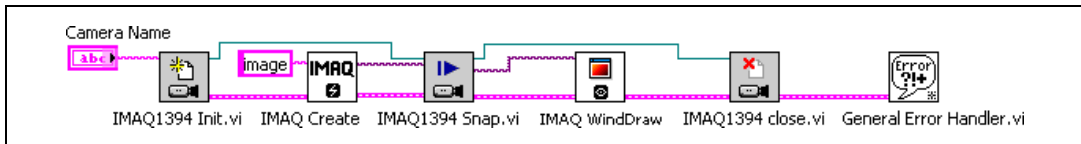


Figure 4-8. Displaying an Image Using IMAQ WindDraw

If you have LabVIEW RT, you can use IMAQ RT Video Out, located at **Vision»Vision Utilities»IMAQ RT**, to display an image on the monitor connected to your RT device. Use IMAQ Video Out Display Mode, located at **Vision»Vision Utilities»IMAQ RT**, to configure the monitor for display. Figure 4-9 illustrates configuring the monitor and displaying an image acquired with IMAQ1394 Snap.

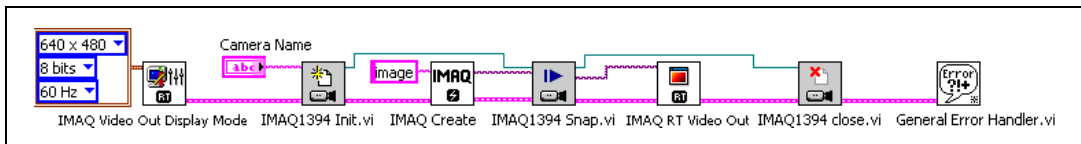


Figure 4-9. Displaying an Image Using RT Video Out



Note The IMAQ RT Video Out VI is available only on RT devices with Intel i815 or i845 video chipsets. These devices include NI CVS-1450 Series devices, PXI-817x controllers, and PXI-818x controllers.

Camera Attributes

To modify camera attributes in LabVIEW, use the IMAQ1394 Property Node. Every camera attribute has three parameters: Attribute Key, Attribute Mode, and Attribute Value.

- **Attribute Key**—Select from a list of supported keys, including **Brightness**, **Gain**, **Shutter Speed**, and **White Balance**. Use IMAQ1394 GetFeatures to return a list of supported camera attributes.
- **Attribute Mode**—Select from a list of supported modes, including **Absolute**, **Auto**, **Off**, **One Push**, **Relative**, and **Ignore**. Use the **Inquiry** property node to determine if a mode is supported by the current camera. The **Ignore** mode is supported by all cameras
- **Attribute Value**—Enter a numeric value for the attribute. This parameter applies only to camera attribute when using **Absolute** or **Relative** camera mode. Use the **Range** property nodes to find the valid range for the current camera.

Figure 4-10 shows a VI with the shutter camera attribute set to **Absolute** mode with a value of 0.014s.

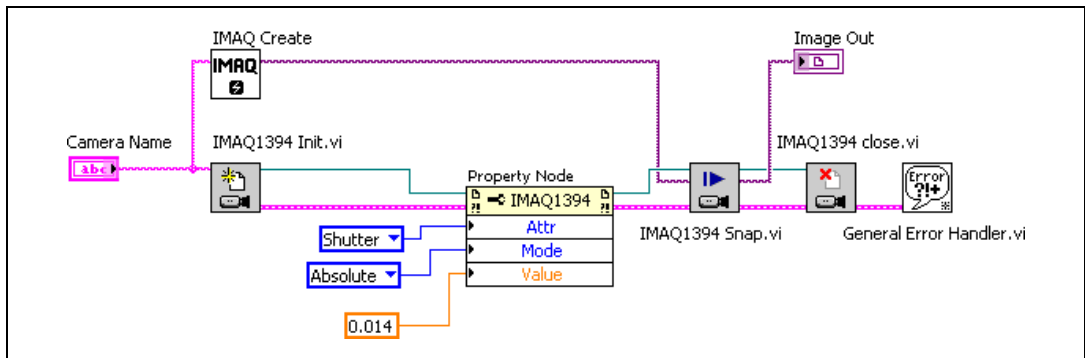


Figure 4-10. Setting Camera Attributes with Property Nodes

Error Handling

Every NI-IMAQ for IEEE 1394 Cameras VI contains an **error in** input cluster and an **error out** output cluster. The clusters, shown in Figure 4-11, contain a Boolean value that indicates whether an error occurred, the code for the error, and the source or the name of the VI that returned the error. If **error in** indicates an error, the VI passes the error information to **error out** and does not execute any NI-IMAQ for IEEE 1394 Cameras function.

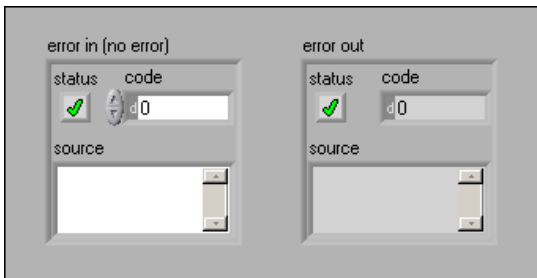


Figure 4-11. Error Clusters

You can use the Simple Error Handler VI, located on the **Functions» Time&Dialog** palette, to check for errors that occur while executing a VI. If you wire an error cluster to the Simple Error Handle VI, the VI deciphers the error information and displays a dialog box that describes the error. If no error occurred, the Simple Error Handler VI does nothing. Figure 4-12 illustrates wiring an NI-IMAQ for 1394 Cameras VI to the Simple Error Handler VI.

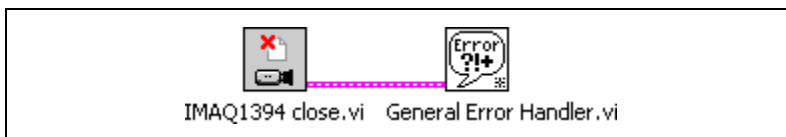


Figure 4-12. Error Checking Using the Simple Error Handler VI

Using NI-IMAQ for IEEE 1394 Cameras in C and .NET

This chapter briefly describes how to use NI-IMAQ for IEEE 1394 Cameras function in Microsoft Visual C and Microsoft Visual Studio .NET.

Using NI-IMAQ for IEEE 1394 Cameras for C

This section outlines the process for developing NI-IMAQ for IEEE 1394 Cameras applications using C for Windows 2000/XP. Detailed instructions about creating project and source files are not included. For information about creating and managing project files, refer to the documentation included with your particular development environment.



Note The generic and high-level functions appear within each function class in the logical order you might need to use them. The low-level functions appear within each function class in alphabetical order.

When programming, use the following guidelines:

- Include the `niimaq1394.h` header file in all C source files that use NI-IMAQ functions. Add this file to the top of your source files.
- Add the `niimaq1394.lib` import library to your project. In some environments, you can add import libraries simply by inserting them into your list of project files. In other environments, you can specify import libraries under the linker settings portion of the project file.
- When compiling, indicate where the compiler can find the NI-IMAQ header files and shared libraries. You can find most of the files you need for development under the NI-IMAQ target installation directory. If you choose the default directory during installation, the target installation directory is `C:\Program Files\National Instruments\NI-IMAQ for IEEE-1394`. You can find the

include files under the `include` subdirectory. The import libraries for Microsoft Visual C++ are located under the `lib\msvc` subdirectory.

If you have IMAQ Vision for LabWindows/CVI installed on your computer, you can use the additional Image functions installed with NI-IMAQ for IEEE 1394 Cameras. These functions use the IMAQ Vision memory management feature, which automatically allocates the memory for your image. To use these Image functions, first create an image using `imaqCreate`, and then pass that image to an acquisition function.

If you are using LabWindows/CVI but do not have IMAQ Vision installed, you must manually allocate the memory for your image. Use the **ImageWidth**, **ImageHeight**, and **BytesPerPixel** attributes to determine how much memory to allocate.

Using NI-IMAQ for IEEE 1394 Cameras for Microsoft Visual Studio .NET 2003

NI-IMAQ for IEEE 1394 Cameras installs the following assemblies that enable .NET languages to interact with the driver software:

- `NationalInstruments.CWIMAQ1394.Interop.dll`
- `NationalInstruments.AxCWIMAQControlsLib.Interop.dll`—
Uses IMAQ Vision to display images with the included Viewer control

The `CWIMAQ1394` assembly is installed in the `<NI-IMAQ 1394>\dotNET\Assemblies\Current` directory. The `AxCWIMAQControlsLib` assembly is installed in the `<Vision>\dotNET\Assemblies\Current` directory. Refer to the *NI-IMAQ for IEEE 1394 Cameras Function Reference Help* for information about the properties, methods, and events available with these assemblies.

Creating a New .NET Application

You first must add a reference to the `NI-IMAQ 1394` assembly in your project when creating a new application. Complete the following steps to add a reference to the `NI-IMAQ 1394` assembly in Microsoft Visual Studio .NET 2003:

1. Create a new application, or open an existing one.
2. Select **Project»Add Reference**.
3. Under the **.NET Framework Components** tab, select **NI-IMAQ 1394**.

If you need to display acquired images, you also must add an IMAQ Vision Viewer control to your toolbox and to your form. Complete the following steps to add the IMAQ Vision Viewer control to the Microsoft Visual Studio .NET 2003 toolbox.

1. With your project open, open a form in Design View.
2. Open the Toolbox (**View»Toolbox**).
3. Select the category in which you want the IMAQ Vision controls to appear (General, Components, and so on).
4. Select **Tools»Add/Remove Toolbox Items**.
5. Under the **.NET Framework Components** tab, select the CWIMAQViewer control.

When the Viewer control is in the toolbox, you can add it to your forms by clicking on the tool and drawing an area on the form. References to the IMAQ Vision Interop Assemblies are automatically added to your project.

Register-Level Programming

This appendix explains how to access and program register locations using the NI-IMAQ for IEEE 1394 Cameras software, and discusses the caveats involved in programming registers.

Introduction

All IEEE 1394 cameras communicate to the host computer through register maps. The register map reflects the system memory located on the IEEE 1394 camera. The register map allows the host computer to read and write information with minimal overhead.

The host computer sends *asynchronous* messages over the IEEE 1394 bus to the connected camera. When the data is written into memory on the IEEE 1394 camera, the camera processes the incoming request. If possible, the camera responds immediately. Otherwise, a pending transaction message is returned. When the pending request is completed, the IEEE 1394 camera returns the results of the request.

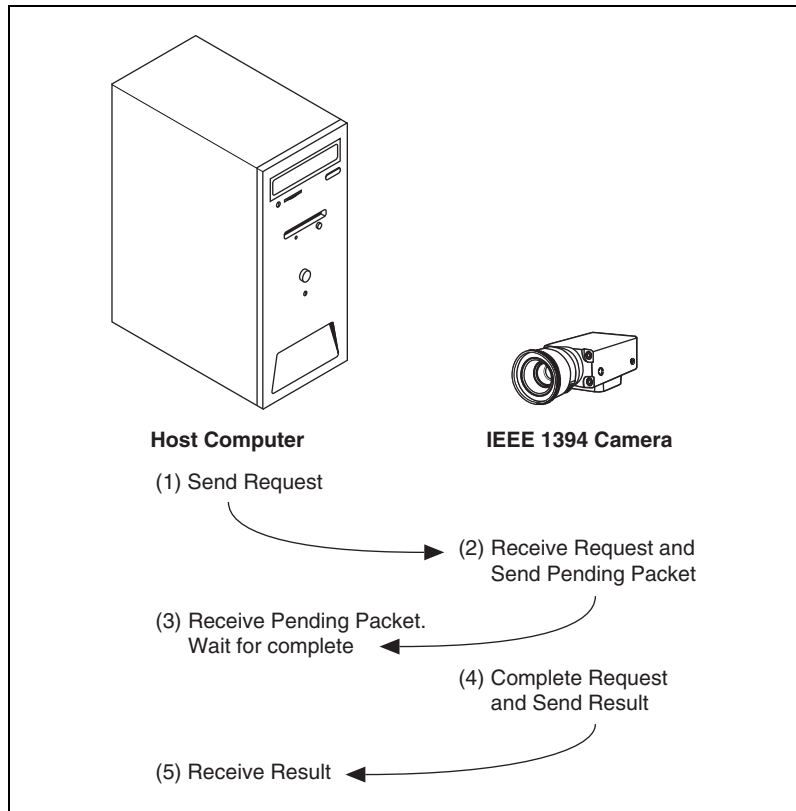


Figure A-1. Explanation of Split Transactions

NI-IMAQ for IEEE 1394 Cameras 2.0 supports the 1394 Trade Association IIDC 1.31 register specification for industrial cameras. Most of the intricacies of register-level programming are abstracted by the driver. The driver is responsible for manipulating camera features and activating/deactivating the video data stream.

Some cameras implement additional registers that are not contained in the IIDC 1.31 specification. These advanced camera features are not natively supported by the camera driver. To use these advanced features, you must use the low-level, register-level access tools to communicate with the camera.

The NI-IMAQ for IEEE 1394 Cameras software provides the following register-level primitives:

- Read Quadlet—Reads a *quadlet* from a specified memory location
- Write Quadlet—Writes a quadlet to a specified memory location

- Read Quadlet Block—Reads an array of quadlets from a specified memory location and range
- Write Quadlet Block—Writes an array of quadlets to a specified memory location



Note In LabVIEW, only the quadlet block variants are exposed.

Usage

To perform a register-level access, specify a memory location (or offset) and data storage. IEEE 1394 memory locations are specified as 48-bit values. The upper 20 bits are filled in by the driver. The low-level register primitives accept the lower 28-bit offset. The memory storage contains the result/desired data when transferring.

Basic Example

The isochronous enable register indicates active video transmission. To read the ISO_EN register (0x614), calculate the memory offset by adding the specified offset to the base register. The base register is 0xF0F00000 for most IEEE 1394 cameras.

$$0xF0F00000 + 0x614 = 0xF0F00614$$

The value is read, and the result is placed in the specified memory location.

$$\text{read quadlet}(0xF0F00614) = \langle iso_en \rangle$$

where $\langle iso_en \rangle = (0x80000000 \text{ or } 0x00000000)$.

If bit 0 has a value of 0x80000000, the bit is on, and the camera is transmitting video data. If bit 0 has a value of 0x00000000, the camera is not currently transmitting data.

Advanced Example

The advanced feature described in this example is specific to Basler IEEE 1394 cameras. The advanced feature replaces the live video feed with a static test pattern.

According to the user documentation for the Basler A601f camera, the TEST_IMAGE register is located at advanced offset 0x0098. You can enable a static test pattern by setting bit 17 of the TEST_IMAGE register. To get the advanced base register, first read ADVANCED_FEATURE_INQ

register (0x480). Add the specified offset to the base register—0xF0F00000 for most IEEE 1394 cameras.

$$0xF0F00000 + 0x480 = 0xF0F00480$$

Read the value into storage.

```
read quadlet (0xF0F00480) = <advanced_feature_inq>
```

where <advanced_feature_inq> = 0x800000.

Now, calculate the offset to the advanced feature offset. You need to multiply the previous result by 4 to convert the quadlet offset value to byte offset.

$$(0xF0F00000 + (<advanced_feature_offset> \times 4) + 0x98) = \text{newly calculated offset}$$

```
byte swap (1 << 17) = newly calculated register mask
```

```
write quadlet (0xF2F00098, 0x00002000)
```

Now the camera is set to the test pattern.

Caveats

This section discusses caveats to consider when programming registers using the NI-IMAQ for IEEE 1394 Cameras software.

Endianness

Data that spans multiple bytes, such as a quadlet, may be written left-to-right or right-to-left. The method with which data is written is called *endianness*. Two types of endianness exist: *big endian* and *little endian*.

The IEEE 1394 bus transports data using the big endian method. However, Windows and LabVIEW RT host machines accept little endian data. To correct for this discrepancy, NI-IMAQ for IEEE 1394 Cameras byte-swaps every quadlet that is read or written with low-level register primitives.

Quadlet Array

Many IEEE 1394 cameras allow register-level access to more than 32 bits of data per communication request. In most cases, you can safely write and read a large, contiguous block of data to and from the connected camera. Some cameras fail when trying to access large payloads. If the camera does not successfully transfer an array of quadlets, attempt to transfer the quadlets one at a time.

Timing

Many IEEE 1394 cameras are responsive to successive register accesses. In most cases, you can safely read and write registers as quickly as possible. Some cameras lock up under stressed conditions. The camera driver inserts an artificial delay between register accesses. You can change this artificial delay in the registry under the following registry key:

```
HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Services\  
imaq1394k\Parameters\AsyncTransferDelay.
```

The key specifies the millisecond value to delay before each transaction. After changing the value, reboot the host computer to enable the changes.



Note Changing this delay affects the entire driver, not just register-level access.

Invalid Memory Location

The NI-IMAQ for IEEE 1394 Cameras software allows access to register locations that do not exist. If an error occurs while accessing the register, check the validity of the register location.

Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Online technical support resources at ni.com/support include the following:
 - **Self-Help Resources**—For answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on.
 - **Free Technical Support**—All registered users receive free Basic Service, which includes access to hundreds of Application Engineers worldwide in the NI Developer Exchange at ni.com/exchange. National Instruments Application Engineers make sure every question receives an answer.

For information about other technical support options in your area, visit ni.com/services or contact your local office at ni.com/contact.
- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.

Glossary

A

acquisition window	The image size specific to a video standard or camera resolution.
address	Value that identifies a specific location (or series of locations) in memory.
API	Application programming interface.
area	A rectangular portion of an acquisition window or frame that is controlled and defined by software.
array	Ordered, indexed set of data elements of the same type.
aspect ratio	The ratio of a picture or image's width to its height.
asynchronous	(1) Independent in time from any other event. (2) Communication mechanism on the IEEE 1394 bus, which guarantees delivery of the message but does not guarantee timing.

B

big endian	Describes computers that store bytes of memory by placing the most significant byte at the memory location with the lowest address, the next significant byte at the next memory location, and so on.
buffer	Temporary storage for acquired data.

C

camera session	A process-safe handle to a IEEE 1394 camera.
chroma	The color information in a video signal.

D

default setting	A default parameter value recorded in the driver. In many cases, the default input of a control is a certain value (often 0).
-----------------	---

DLL Dynamic Link Library—A software module in Microsoft Windows containing executable code and data that can be called or used by Windows applications or other DLLs; functions and data in a DLL are loaded and linked at run time when they are referenced by a Windows application or other DLLs.

driver Software that controls a specific hardware device, such as an IEEE 1394 camera.

E

endianness The convention describing the ordering of bytes in memory or the sequence in which bytes are transmitted.

external trigger A voltage pulse from an external source that triggers an event such as A/D conversion.

F

FIFO First-In First-Out—The first data stored in the memory buffer is the first data sent to the acceptor. FIFOs are used on IMAQ devices to temporarily store incoming data until that data can be retrieved.

function A set of software instructions executed by a single line of code that may have input and/or output parameters and returns a value when executed.

G

gamma The nonlinear change in the difference between the video signal's brightness level and the voltage level needed to produce that brightness.

grab Performs an acquisition that loops continually on one buffer. You obtain a copy of the acquisition buffer by grabbing a copy to a separate buffer that can be used for analysis.

H

hardware abstraction layer Separates software API capabilities, such as general acquisition and control functions, from hardware-specific information.

hue Represents the dominant color of a pixel. The hue function is a continuous function that covers all the possible colors generated using the R, G, and B color spectrum. *See also* [RGB](#).

I

I/O Input/Output—The transfer of data to/from a computer system involving communications channels, operator interface devices, and/or data acquisition and control interfaces.

IEEE Institute of Electrical and Electronics Engineers.

internal buffer A page-locked buffer. *See also* [page-locked buffer](#).

L

library A file containing compiled object modules, each comprised of one or more functions, that can be linked to other object modules that make use of these functions.

little endian Describes computers that store bytes of memory by placing the least significant byte at the memory location with the lowest address, the second least significant byte at the next memory location, and so on.

luma The brightness information in the video picture. The luma signal amplitude varies in proportion to the brightness of the video signal and corresponds exactly to the monochrome picture.

M

MAX Measurement & Automation Explorer—A controlled, centralized configuration environment that allows you to configure all of your NI devices.

N

NI-IMAQ Driver software for National Instruments IMAQ hardware.

P

page-locked buffer	Memory page that is marked as non-pagable by the virtual file system. Page-locked buffers remain in physical memory and do not cause page faults
pixel	Picture element. The smallest division that makes up the video scan line. For display on a computer monitor, a pixel's optimum dimension is square (aspect ratio of 1:1, or the width equal to the height).
process-safe handle	A handle that allows only one process to access a camera at any given time.
protocol	The exact sequence of bits, characters, and control codes used to transfer data between computers and peripherals through a communications channel.

Q

quadlet	A 32-bit (four-byte) word.
---------	----------------------------

R

real time	A property of an event or system in which data is processed as it is acquired instead of being accumulated and processed at a later time.
resolution	(1) The number of rows and columns of pixels. An image composed of m rows and n columns has a resolution of $n \times m$. This image has n pixels along its horizontal axis and m pixels along its vertical axis; (2) The smallest signal increment that can be detected by a measurement system. Resolution can be expressed in bits, proportions, or a percentage of full scale. For example, a system has 12-bit resolution, one part in 4,096 resolution, and 0.0244 percent of full scale.
RGB	Color encoding scheme using red, green, and blue (RGB) color information where each pixel in the color image is encoded using 32 bits: 8 bits for red, 8 bits for green, 8 bits for blue, and 8 bits for the alpha value (unused).
ROI	Region of Interest—(1) An area of the image that is graphically selected from a window displaying the image. This area can be used focus further processing; (2) A hardware-programmable rectangular portion of the acquisition window.

S

sequence	Performs an acquisition that acquires a specified number of buffers, then stops.
snap	Acquires a single image to a buffer.
syntax	Set of rules to which statements must conform in a particular programming language.

T

timeout	Length of time, in milliseconds, that the driver waits for an image from the camera before returning an error
transfer rate	The rate, measured in bytes/s, at which data is moved from source to destination after software initialization and set up operations. The maximum rate at which the hardware can operate.
trigger	Any event that causes or starts some form of data capture.

U

user buffer	A memory buffer created by the user as a destination for the image. In LabVIEW, this is created with the IMAQ Create VI.
UV plane	<i>See YUV.</i>

V

VI	Virtual Instrument. (1) A combination of hardware and/or software elements, typically used with a PC, that has the functionality of a classic stand-alone instrument; (2) A LabVIEW software module (VI), which consists of a front panel user interface and a block diagram program.
----	---

Y

YUV

A representation of a color image used for the coding of NTSC or PAL video signals. The luma information is called Y, while the chroma information is represented by two components, U and V representing the coordinates in a color plane.

Index

Symbols

.NET programming language, 1-4, 3-1, 5-1, 5-2, 5-3

A

advanced programming examples
 grab using low-level functions, 2-13
 sequence using low-level functions, 2-14
 snap using low-level functions, 2-12
application development, 1-2
 .NET, 4-1, 5-2
 C, 5-1
 environments, 1-2
 LabVIEW, 4-1
 LabVIEW Real-Time Module, 4-1
 NI-IMAQ for IEEE 1394 libraries, 1-3

B

Bayer, 1-1, 2-8
block diagram, LabVIEW, 4-1, 4-2, 4-7
 grab, 4-5
 sequence, 4-6
 snap, 4-5
broadcasting, 2-4, 3-1
 figure, 3-2
buffers, 4-3, 4-5
 internal, 2-1, 2-4 to 2-14, 4-5
 management, 4-4
 number, 2-5, 2-6
 user, 2-1, 2-5, 2-6, 2-9, 2-10

C

C programming language, 1-2, 3-1, 3-3, 5-1

camera
 attributes, 2-1, 2-3, 2-4, 3-1, 3-3
 setting camera attributes in C, 3-1
 setting camera attributes in
 LabVIEW, 4-9
 setting camera attributes in Visual Basic
 and .NET, 3-1
 configuration, 1-2
 naming convention (table), 2-3
 output formats, 1-1
camera control mode, 2-2, 2-4, 3-3
camera files, 1-2, 2-3
configuration
 camera, 1-2
 interface, 2-4
controller
 broadcasting, 3-2, 3-3
 camera control mode, 2-4
conventions used in the manual, *iv*

D

decoding video modes, 2-7
 table, 2-8
diagnostic tools (NI resources), B-1
display. *See* image display
documentation
 conventions used in the manual, *iv*
 NI resources, B-1
drivers (NI resources), B-1

E

endianess, 2-8, A-4
enumerate function, 2-3
error handling, 4-9

examples

- advanced programming examples, 2-11
- introductory programming examples, 2-8
- location of files, 1-4

examples (NI resources), B-1

F

features and overview, 1-1

Format 7 video mode, 2-5, 3-1, 3-3

- figure, 3-4

front panel, LabVIEW, 4-1, 4-7

G

grab

- high-level, 2-1, 2-6, 2-10, 4-5

 - flowchart, 2-10

 - in LabVIEW (figure), 4-6

- low-level, 2-13

 - flowchart, 2-13

H

help, technical support, B-1

high-level functions, when to use, 2-1

I

image buffer. *See* buffer

image display, 2-1, 2-7, 4-7

- .NET, 5-2, 5-3

- LabVIEW, 4-1, 4-7, 4-8

 - figure, 4-8

- LabVIEW Real-Time Module, 4-8

 - figure, 4-8

IMAQ Create, 4-3, 4-4

IMAQ Dispose, 4-4, 4-5

IMAQ WindDraw, 4-8

IMAQ1394 Session, 4-2, 4-3

initialization, interface, 2-2

instrument drivers (NI resources), B-1

interface file, 2-3, 4-2

internal buffers, 2-1, 2-4 to 2-14, 4-5

introductory programming examples, 2-8

- high-level grab functions, 2-10

- high-level sequence functions, 2-11

- high-level snap functions, 2-9

K

KnowledgeBase, B-1

L

LabVIEW programming language, 1-2, 3-1, 3-3, 4-1

- block diagram, 4-1, 4-2, 4-5 to 4-7

- front panel, 4-1, 4-7

- property nodes, 4-2, 4-9

LabVIEW Real-Time Module, 1-2, 4-1

LabWindows/CVI programming

- language, 1-2

listener

- broadcasting, 3-2, 3-3

- camera control mode, 2-4

M

MAX, 1-2, 2-3, 2-9, 3-1 to 3-3, 4-3

Measurement & Automation Explorer.

- See* MAX

memory allocation, 2-5, 2-6, 3-3, 4-3, 4-4, 4-5, 5-2

memory offset, A-3, A-4

N

National Instruments support and services, B-1

NI-IMAQ for IEEE 1394 Cameras

- acquisition types

- grab, 4-5

- sequence, 4-6

- snap, 4-5

- acquisition VIs

- high-level VIs, 4-3

- low-level VIs, 4-3

- architecture, 1-2

- libraries, 1-3

O

- overwrite mode, 2-7

P

- Partial Image Size Format. *See* Format 7 video mode

- programming

- guidelines for C, 5-1

- high-level functions, 2-1

- introduction to programming with

- NI-IMAQ for 1394, 2-1

- low-level functions, 2-1

- register-level, A-1

- programming environments supported by

- NI-IMAQ for 1394 software, 1-2

- programming examples (NI resources), B-1

- programming with NI-IMAQ for

- 1394 VIs, 4-5

- buffer management, 4-4

- introduction, 4-1

- location, 4-2

- parameters, 4-2

- property nodes, LabVIEW, 4-2, 4-9

Q

- quadlet arrays, A-3, A-5

R

- region of interest. *See* ROI

- register-level programming, A-1

- caveats, A-4

- RGB, 1-1, 2-7, 2-8, 4-4

- ROI, 2-4 to 2-6, 2-9, 3-3

S

- scalable image size, 3-3

- sequence

- high-level, 2-1, 4-6

- flowchart, 2-11

- in LabVIEW (figure), 4-6

- low-level, 2-14

- flowchart, 2-14

- snap

- high-level, 2-1, 4-5

- flowchart, 2-9

- in LabVIEW (figure), 4-5

- low-level, 2-12

- flowchart, 2-12

- software (NI resources), B-1

- static test pattern, A-3

- support, technical, B-1

T

- technical support, B-1

- timeouts, 2-7, 3-4, 4-7

- training and certification (NI resources), B-1

- triggering

- in LabVIEW, 4-7

- modes, 2-1, 3-4 to 3-7

- troubleshooting (NI resources), B-1

U

- user buffers, 2-1, 2-5, 2-6, 2-9 to 2-10

V

VI parameters, 4-2

video mode

 decoding, 2-7

 table, 2-8

 ROI considerations, 2-5

Visual Basic programming language, 1-2, 3-1

Visual Studio .NET programming

 language, 1-2

Visual Studio .NET. *See* .NET

W

Web resources, B-1

Y

YUV, 1-1, 2-7, 2-8